Amendments to the Drawings:

The attached sheets of drawings include changes to Fig. 5E. These sheets replace the original sheets including Figs 5A – 5E.

Attachment: Replacement Sheet
Annotated Sheets Showing Changes

REMARKS/ARGUMENTS

This communication is responsive to Office Action of July 27, 2004 in which the following objections were raised: [1-2] The abstract of the disclosure was objected to because it exceeded 150 words; [3] The drawings were objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. [4] The drawings were objected to under 37 CFR 1.83(p)(5) because they did not include the reference character(s) mentioned in the description. [5] Claims 1-16 were rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement; [6] Claim 6 was rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter; [7] Claims 1, 7 and 9-12 were rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian; [8] Claims 2-4 and 13-15 were rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian in view of Langberg et al.; [9] Claim 6 was rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian in view of Mannerma.

Applicant has amended Claims 1-2, 4-5, 8-14, 16 and canceled Claims 3, 6-7, 15.

1-2. ABSTRACT OBJECTED TO FOR EXCEEDING 150 WORDS:

The abstract of the disclosure was objected to because it exceeded 150 words.

The Applicant has amended the abstract to less than 150 words.

AMENDMENTS TO THE SPECIFICATION:

Applicant's has noted the omission in the specification of the reference numbers 500, 502 and 504 shown in FIGS. 5A, 5B, 5C respectively, which correspond with the start of the PRN sequence shown in FIG. 5A, the start of the leakage signal shown in FIG. 5B and the start of the first reflection signal in FIG. 5C respectively. The PRN sequence shown in FIG. 5A is clearly shown in both the leakage and reflected signals shown in FIGS. 5B and 5C respectively. The dotted pattern, as opposed to the cross-hatch, marks the start of the PRN

signal 500 in FIG. 5A as well as the start of the reflections thereof 502, 504 shown in FIGS. 5B and 5C in the same dotted pattern.

3. DRAWINGS OBJECTED TO UNDER 37 CFR 1.83(a):

The drawings were objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims.

Support for the switch limitation of Claim 7 is found throughout the specification including: "*...filter 326 that filter may preferably be switchably decoupled from the corresponding path so as not to limit channel estimation.* "(Applicant's Specification at page 13, lines 21-22); and "*In process 602 any interfering transmit filters in the transmit or receive path are de-coupled from the corresponding path.*" (Applicant's Specification at page 18, lines 18-20).

Notwithstanding the above referenced support the Applicant has canceled Claim 7.

4. DRAWINGS OBJECTED TO UNDER 37 CFR 1.83(p)(5):

The drawings were objected to under 37 CFR 1.83(p)(5) because they did not include the reference character(s) 530 and 532 mentioned in the description.

Reference characters 530 and 532 have been added to FIG. 5E to correspond with the specification, where they are identified as the leakage peak and the peak corresponding with the first reflected signal, respectively. "*FIG. 5E shows the correlation factors for the received signal. Two peaks in the ordered set of coefficients are shown, peak 530 and peak 532. Depending on the initial sampling of the composite received signal these could occur in the order shown or could be shifted across/around the correlation graph. In the example shown the leakage peak 530 follows the interval of greatest separation between peaks, i.e. interval 520. This corresponds with the tail of the reflections from the furthest end of the subscriber line in which any reflections are most severely attenuated. The leakage peak is separated by interval 522 from the first correlation coefficient peak 532 which peak corresponds with the first reflected signal from the first discontinuity on the corresponding*

subscriber line, e.g. line 160, discontinuity 162 (See FIG. 1). " (Applicant's Specification at page 10, lines 10-19, Emphasis Added).

5. CLAIMS 1-16 REJECTED UNDER 35 U.S.C. 112:

Claims 1-16 were rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. Specifically the Examiner in Claim 1 questioned with regard to the limitation found in Claims 1 and 12, '*...correlate delays between the leakage signal and each of the reflected signals.*' how the correlator identifies each of the reflected signals' (Office Action of 7-27-2004 at page 4).

Applicant draws the Examiner's attention to the following portions of the Specification and Drawings in which the questioned functionality of the correlator is enabled in multiple self sufficient formats: including written description, mathematical exposition; hardware block diagrams and process flow.

Written Description:

> "*The correlator generates an ordered set of correlation coefficients corresponding with various phasings of the codeword with the composite signal. These coefficients may be stored in memory in the correlator or in memory 248. The correlator detects peaks within these ordered coefficients, identifies which of the peaks corresponds with the leakage signal, and from that information determines the time delay, or offset, of each of the subsequent reflected signals along with their relative magnitudes. This information is then used to characterize the associated subscriber line discontinuities by location and by type...*" (Specification at page 12, lines 19-25, Emphasis Added)
>
> "*The correlator generates correlation coefficients, detects peaks therein including the leakage peak, and sequentially orders the peaks corresponding to each of the reflected signals from each of the discontinuities in the channel with respect thereto.* " (Specification at page 13, lines 25-28).

"FIGS. 4AB show alternate embodiments of the correlator module .... The "N" bits of the complete codeword are stored within the ...codeword buffer 400. ... A circular shifter 402 allows the individual bits of the within the code word register to be circular shifted during correlation of the composite signal on the receive path 314. A loader ...allows the composite received signal...to be loaded into the receive buffer. The number of bits in the received buffer is shown corresponding with the number of bits in the codeword, though this need not be the case.

Once the code word and received signal are loaded into their respective buffers each bit of the codeword buffer is multiplied by a corresponding bit in the receive buffer by a corresponding multiplier within the multiplier bank and the results are placed in corresponding bit locations within summer 412. ... Then the contents of the summer are added and the corresponding correlation coefficient $K(L_n)$ is stored in the coefficient table 462 within memory 414. Then the codeword is shifted via shifter 402 and the process is repeated for the calculation of the next correlation coefficient. This is continued at least until the complete codeword has been rotated and the process may be repeated is averaging of coefficients across multiple sample sets is called for as a way of increasing the accuracy of the result.... After the coefficient table 462 is completed with an ordered set of the calculated coefficients ...., the ordered correlation coefficients of table 462 are provided to detector 418. Detector 418 includes the peak detector 450, a leakage the detector 452, and the sequencer 454. The peak detector 450 determines the location and number of the peaks within the ordered coefficient list. This may be done using a number of techniques well known to those skilled in the art including a fixed threshold a crossing and recrossing of which signifies a peak or valley. Next the leakage peak detector 452 determines on the basis of the relative spacing between peaks which among the peaks is the leakage peak. The leakage peak in an embodiment of the invention is the first peak following the tail of the echoes. It is the peak the location of which is spaced furthest apart in the correlation coefficient table from a preceding peak. The sequencer then orders each of the reflective peaks which correspond to each of the reflective signals with respect to leakage peak in terms of both their offset in relative magnitude. This information is then provided on output 328. This information may then be processed

further to determine the location of the discontinuity based on signal propagation times within the subscriber line and the offset of the corresponding reflection peak from the leakage peak. Additionally the magnitude and other parameters of each reflective peak may be compared with known values for various types of line discontinuities such as taps, and bridges to identify the discontinuity not only by location but by type. Channel or line estimation may also be used to disqualify, or qualify a particular line for one or more of the X-DSL protocols. "(Specification at page 13, line 29 through page 15, line 14 Emphasis Added)

Mathematical Exposition:

"*The system starts by transmitting a pre-defined pseudo-random sequence generated in time. ... The received signal is the supper-position of the leakage of the transmitted signal via the hybrid 308 (See FIG. 3) and the reflections of the signal due to discontinuous in the line. The received signal is mathematically modeled as:*

$$r(n) = \sum_{i=0}^{M} \alpha_i p(n-\tau_i) \qquad \textit{Equation 1}$$

where $\alpha_0 p(n-\tau_0)$ *is the leaked transmit signal via the hybrid circuitry, and the terms corresponding to* $i = 1,\ldots,M$ *is caused by the reflection of the discontinues of the line. At the receiver, the received signal r(n) is cross-correlated against the same pseudo-random sequence generated locally. Assuming a feedback shift-register m-sequence was utilized as the pseudo-random sequence, the cross-correlation function is presented below:*

$$K(l) = \sum_{n=0}^{N-1} r(n)p(n-l) = \left(\sum_{i=0}^{M} (N+1)\alpha_i \delta(l-\tau_i)\right) - 1 \textit{ for } l = 0,\cdots,N-1 \qquad \textit{Equation 2}$$

where

$$\delta(l-k)=\begin{cases}1 & k=l\\ 0 & k\neq l\end{cases}$$ *Equation 3*

In the above calculation of $K(l)$, it is assumed that p(n) is periodic with period N. The receiver by observing $K(l)$will utilized the calculated the values of α_i for $i=1,\ldots,M$ and $d_i=\tau_i-\tau_0$for $i=1,\ldots,M$ to estimated the line insertion loss....

The line insertion loss will be an indication of the possible data throughput of the line, which will determine if the line is qualified to carry a given DSL service. FIG. 5A shows one period of m-sequence, of period 2^4-1 =15. The transmitted sequence is a repeated version of the m-sequence shown in FIG. 5A. The received sequence shown in FIG. 5D, is a super-position of the transmit leakage via hybrid shown in FIG. 5B as well as the reflection shown in FIG. 5C. The shift 522 between the two is $\tau_1-\tau_0=3$. The relative magnitudes are $\alpha_0=0.5$, $\alpha_0=0.25$ respectively. The cross correlation shown in FIG. 5E is done in a circular fashion."(Specification at page 17, line 7 through page 18, line 15)

Hardware Block Diagrams:

FIGS. 4A-4B show alternate embodiments of the correlator.

Process Flow:

FIGS. 5A-5E show a transmitted PRN sequence, leakage signal, a first reflected signal, a composite of the leakage and reflected signals and a representative resultant cross correlation thereof.

FIG. 6 is a process flow diagram of the channel estimation processes in which the presence of reflected signals and the offset of those signals with respect to the leakage signal are determined.

"In process 602 any interfering transmit filters in the transmit or receive path are de-coupled from the corresponding path. ... the PRN generator ...injects a code word with period "N" into the transmit path. ...a receive signal of duration "N" bits

is loaded into the receive buffer 406 (See FIG. 4A). ... N bits of the PRN codeword are loaded into the corresponding locations within codeword buffer 400 (See FIG. 4A). ...In process 610 to the first/next shift of the PRN codeword in buffer 400 is accomplished by shifter 402 (See FIG. 4A). ... each corresponding bit within the codeword buffer is multiplied by the corresponding bit in the receive sample buffer 406 and passed to the corresponding locations in summer 412 (See FIG. 4A). ... the multiplication results are summed to produce the corresponding correlation coefficient $K(L_n)$. ... this coefficient is stored in the coefficient table 462 (See FIG. 4A). ... a determination is made as to whether there are any remaining shifts of the codeword buffer. ....the ordered set of correlation coefficients is retrieved from memory 414 and the peaks within the correlation coefficients are determined. Control than passes to process 624 for a determination of the spacing between peaks including the spacing between the last peak and the first peak. Next in process 626 the leakage peak is determined on the basis of the differences determined in process 624. The leakage peak as discussed above follows the greatest inter peak separation/spacing. The leakage peak follows the tail of the reflected signals which corresponds with this spacing. Depending on the phasing of the sampling of the composite signal on the receive signal path the leakage peak may correspond with the first, the last, or an intermediate one of the peaks within the ordered set of correlation coefficients. Control than passes to process 628 in which the amplitude and offset of each subsequent peak with respect to the leakage peak determined. These results may be subject to further processing for the determination of line characteristics i.e. discontinuity location and discontinuity type. " (Specification at page 18, line 18 through page 19, line 26 Emphasis Added)

The Applicant therefore respectfully submits that the method and apparatus by which the correlator identifies each of the reflected signals, i.e. by determining the peaks following the leakage peak in the ordered coefficient list, is fully supported in throughout the specification.

The Applicant therefore respectfully requests that this rejection be withdrawn.

6. CLAIM 6 REJECTED UNDER 35 U.S.C. 112:

Claim 6 was rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter.

The Examiner is correct that the circular shift register 402 is part of the embodiment of the correlator shown in FIG. 4B which is coupled to the receive path. The periodicity N is the periodicity of the PRN sequence transmitted on the transmit path.

Applicant appreciates the Examiner's detailed rejection, and has canceled Claim 6.

7. CLAIMS 1, 7 AND 9-12 REJECTED UNDER 35 U.S.C. 103(a):

Claims 1, 7 and 9-12 were rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian.

Applicant has canceled Claim 7 and amended Claims 1 and 9-12. Claims 1 and 12 are Independent Claims which in amended form contain limitations not disclosed or taught in any of the references including the Vereljian reference. The Vereljian reference discloses an echo canceller comprising a finite impulse response (FIR) for a DSL modem. A FIR does not perform a cross-correlation function between a codeword and a received signal, rather it develops weighting factors sufficient to cancel an echo portion of a received signal.

The Vereljian reference does not disclose a PRN generator, nor a correlator which correlates the PRN codeword against a received signal, nor a detector to detect peaks within an ordered set of correlation coefficients each of which are elements or processes as found in Applicant's amended Independent Claims 1 and 12 and by extension of dependent claims 9-10.

The Applicant therefore respectfully requests that the Examiner withdraw this grounds for rejection.

8. CLAIMS 2-4 AND 13-15 REJECTED UNDER 35 U.S.C. 103(a):

Claims 2-4 and 13-15 were rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian in view of Langberg et al.

Applicant has amended dependent Claims 2, 4, 14 and canceled dependent Claims 3, 15.

Examiner has characterized the Langberg et al. reference as teaching a *"...DSL modem transmitting a codeword in a pseudo random sequence..."* and the Applicant concurs with that characterization to the limited extent set forth herein. Indeed Langberg discloses a modem transmitting a pseudo random sequence and a correlator. However, unlike the Applicant's claimed invention, the PN sequence in Landberg et al. is generated on a transmitting one of a pair of modems and correlated on a remaining receiving one of the pair receiving modem, for purposes of synchronizing the opposing modems. *"...the long PN sequence allows the receiving transceiver 14 to use a correlator to uniquely identify that the transmitting transceiver 12 has, in fact, sent...."*(Langberg at col 3, lines 59-61, and FIG. 1, Emphasis Added).

The Applicant's claimed invention by contrast does involve or require a modem on the opposing end the subscriber line since the Applicant's claimed PRN generator and correlator are on the same communication device, with an entirely different purpose and functionality, namely channel characterization. Additionally, the Langberg et al. reference does not disclose a detector as claimed by the Applicant.

Applicant's amended dependent Claims 2, 4, 14 are thus believed to have been placed in a condition for allowance for the reasons discussed above with respect to both of the references. The Applicant therefore respectfully requests that the Examiner withdraw this grounds for rejection.

9. CLAIM 6 REJECTED UNDER 35 U.S.C. 103(a):

Claim 6 was rejected under 35 U.S.C. 103(a) as being unpatentable over Vareljian in view of Mannermaa.

Applicant has canceled Claim 6.

CONCLUSION

In view of the above remarks, and the amendments to the Claims, Applicant respectfully submits that all remaining Claims 1-2, 4-5, 8-14, 16 have been placed in a condition for allowance, and requests that they be allowed. Early notice to this effect is solicited.

The Commissioner is authorized to charge any additional fees which may be required, including petition fees and extension of time fees, to Deposit Account No. 50-1338 (Docket No. VELCP008X1C).

Respectfully submitted,
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JAN 27 2005
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FIG. 5A

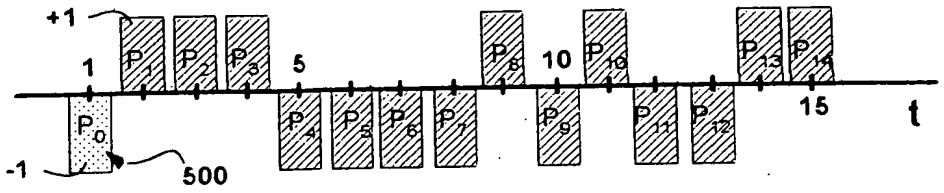

FIG. 5B

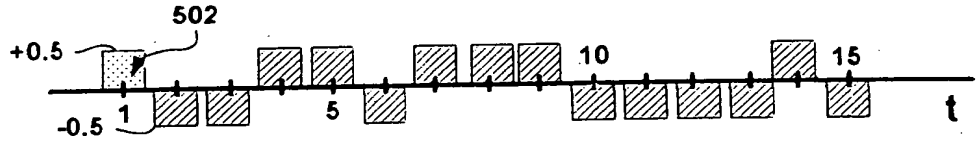

FIG. 5C

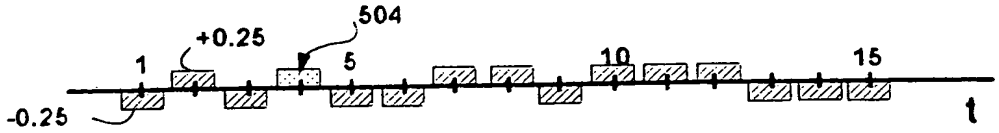

FIG. 5D

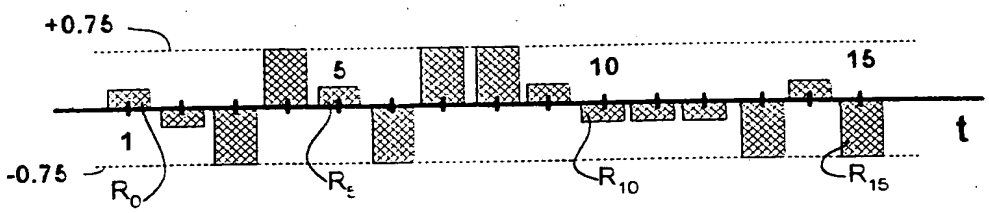
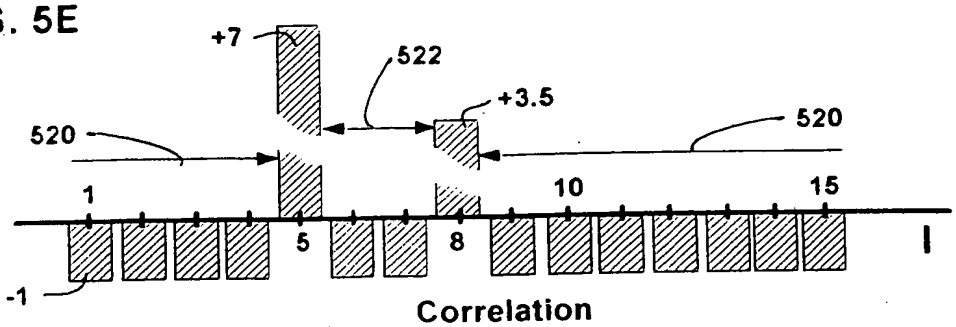
FIG. 5E